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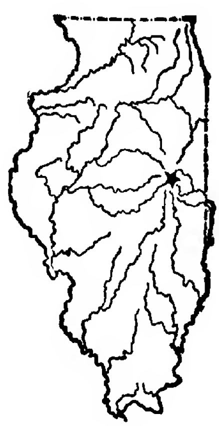
A NEW LIMESTONE TESTER

BY CYRIL G. HOPKINS



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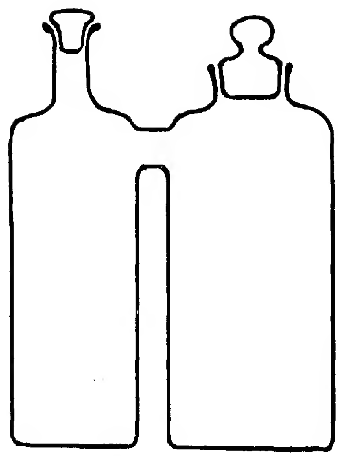

Limestone Tester

(Weight, about 40 grams. Capacities below connecting tube, about 35 cc. and 50 cc. respectively)

A NEW LIMESTONE TESTER

By CYRIL G. HOPKINS, Chief in Agronomy and Chemistry

Since the publication of Circular 185, describing a limestone tester, the writer has designed a more simple apparatus by means of which the purity of limestone can be quickly ascertained with a very satisfactory degree of accuracy.

As shown in the accompanying illustration, this tester consists of two small glass bottles, joined together and fitted with ground-glass stoppers, the stopper of the smaller bottle resting upon a surface only slightly inclined from the horizontal, and projecting loosely into the neck. A set of weights from 5 milligrams to 50 grams, a balance suitable for these weights with a capacity of 100 grams, a thermometer, a 25 cubic centimeter graduated cylinder, and the limestone tester, are all one needs for testing limestone for relative purity.

To make the test, place 5 grams of pulverized limestone in the larger bottle and fill the smaller one to the side-opening with acid made by mixing about equal parts of concentrated hydrochloric acid and water and saturating with carbon dioxid. Insert the stoppers and weigh. Now tip the apparatus carefully until the acid begins to flow thru the side-opening. As it drops upon the limestone, the carbonate is changed to chlorid and the liberated carbon dioxid gas passes thru the side-opening, lifting the small stopper as it passes out. Partly immerse the apparatus in cool water to keep it at about room temperature. Gradually transfer the acid until foaming[1] ceases; then dry the apparatus with a soft cloth, weigh, and note the loss. To this loss in weight add .6 milligram for each cubic centimeter of air-space in the "loaded" apparatus, then deduct the proper percentage for the room temperature (about 1 percent for 70° F.—see Table 1), and divide by 2.2 to get the relative purity of the stone.

If the direct loss represented only the total carbon dioxid liberated, then its weight divided by 2.2 would give the relative purity of the stone in terms of calcium carbonate, since 5 grams of pure calcium carbonate ($CaCO_3$) contains 2.2 grams of carbon dioxid (CO_2), the atomic weights being 40 for calcium, 12 for carbon, and 16 for oxygen.

However, the moist air which fills the air-space at the beginning is replaced by moist carbon dioxid during the reaction. At 70° Fahrenheit (21° centigrade) and 29.33 inches (745 millimeters) barometric

[1]Too persistent frothing may be prevented by adding a few drops of gas-engine cylinder oil to the acid before weighing the "loaded" apparatus.

pressure (taken as room temperature and average atmospheric pressure at an elevation of 600 feet above sea level), 1 cubic centimeter contains 1.744 milligrams of carbon dioxid or 1.148 milligrams of air, not including the water vapor. The difference in weight is practically .6 milligram per cubic centimeter; and, if the air-space in the "loaded" apparatus is, for example, 75 cubic centimeters, then 45 milligrams should be added to the loss in weight, under these conditions.

Again, the gas (air or carbon dioxid) passing out of the apparatus during the reaction is accompanied by some water vapor, which amounts to .018 milligram per cubic centimeter at 70° F. The combined weight of the carbon dioxid and water vapor in 1 cubic centimeter, at 70° F. and 29.33 inches, is 1.762 milligrams (1.744 + .018). Thus, about 1 percent must be deducted from the first corrected weight.

For example, 5 grams of a certain limestone shows a loss of 1.990 grams. The first correction (45 milligrams) increases this to 2.035 grams, and the second correction (20 milligrams) reduces it to 2.015 grams. This divided by 2.2 gives .916, or 91.6 percent, as the relative purity of the stone.

For all practical purposes, the first correction is a constant for each apparatus, the variations for ordinary differences in temperature and pressure being negligible. The second correction varies appreciably only with change of temperature. For each 2 degrees above 70°, the correction of 1 percent is increased by about .1 percent. Thus, if the room temperature is 86°, add to the weight of escaped gas .6 milligram per cubic centimeter of air-space and then deduct 1.74 percent (see Table 1). This, in the above example, with a direct loss of 1.990 grams, would give a final corrected weight of 2.000 grams of carbon dioxid from 5 grams of stone, and this divided by 2.2 gives 90.9 percent. But to perform the operation at 86° and figure the second correction at 1 percent, as should be done for 70°, would introduce an error of .7 percent in the purity found.

To saturate the hydrochloric acid with carbon dioxid, drop a piece of limestone weighing 3 or 4 grams into a pint bottle of the diluted acid, replacing the stopper after foaming ceases.

To determine the air-space in the "loaded" apparatus, place 5 grams of pulverized limestone in the larger bottle, fill the smaller bottle to the side-opening with water, and then pour in measured water from a graduated cylinder and note the addition required to completely fill the apparatus.

If one has a barometer, and a balance capable of weighing to 1 milligram, a still higher degree of accuracy may be secured by using the data given in the accompanying tables.

Thus, 5 grams of pulverized limestone shows a direct loss of 2.164 grams at 77° and 28.50 inches, with an apparatus having 71 cubic centimeters air-space when "loaded." When saturated with water

TABLE 1.—CARBON DIOXID SATURATED WITH WATER VAPOR AT 760 MILLIMETERS (29.92 INCHES)

Temperature		Milligrams per cubic centimeter			Percent of water in total	Pressure of water vapor *millimeters*
°C	°F	Carbon dioxid	Water vapor	Total		
10	50.0	1.879	.009	1.888	.50	9.2
11	51.8	1.870	.010	1.880	.53	9.8
12	53.6	1.862	.011	1.872	.57	10.5
13	55.4	1.853	.011	1.864	.61	11.2
14	57.2	1.844	.012	1.856	.65	11.9
15	59.0	1.836	.013	1.848	.69	12.7
16	60.8	1.827	.013	1.840	.73	13.5
17	62.6	1.818	.014	1.832	.78	14.4
18	64.4	1.809	.015	1.824	.83	15.4
19	66.2	1.800	.016	1.816	.89	16.3
20	68.0	1.791	.017	1.808	.95	17.4
21	69.8	1.782	.018	1.800	1.01	18.5
22	71.6	1.773	.019	1.792	1.08	19.7
23	73.4	1.763	.020	1.784	1.15	20.9
24	75.2	1.754	.022	1.775	1.22	22.2
25	77.0	1.744	.023	1.767	1.29	23.6
26	78.8	1.735	.024	1.759	1.37	25.0
27	80.6	1.725	.026	1.751	1.46	26.5
28	82.4	1.715	.027	1.742	1.55	28.1
29	84.2	1.705	.029	1.734	1.64	29.8
30	86.0	1.695	.030	1.725	1.74	31.5
31	87.8	1.685	.032	1.716	1.85	33.4
32	89.6	1.674	.033	1.707	1.96	35.4
33	91.4	1.664	.035	1.699	2.08	37.4
34	93.2	1.653	.037	1.690	2.20	39.6
35	95.0	1.643	.039	1.682	2.34	41.8

vapor under those conditions, 1 cubic centimeter contains 1.659 milligrams of carbon dioxid or 1.093 milligrams of air, the difference being .566 milligrams, or 40 milligrams in 71 cubic centimeters. This first correction being added gives 2.204 grams of moist carbon dioxid, of which 1.29 percent, or 28 milligrams, is water vapor, leaving 2.176 milligrams of dry carbon dioxid, and this divided by 2.2 gives 98.9 percent; whereas, if the barometric pressure were assumed to be 29.33 inches, the purity found would be 99.0 percent, as may readily be computed from the data given in Tables 1, 2, and 3.

NOTE.—This method of testing for relative strength or purity serves to measure the basicity (power to neutralize acidity) of dolomitic as well as of the more common limestone, but to hasten the reaction it is well to pulverize dolomite so it will pass thru a 100-mesh sieve.

TABLE 2.—WEIGHT OF DRY CARBON DIOXID IN MILLIGRAMS PER CUBIC CENTIMETER OF SATURATED GAS

(Corrected for water vapor, etc.—Parr's Table: J. Am. Chem. Soc., 31, 237)

°C. \ mm.	720	722	724	726	728	730	732	734	736	738	740	742	744	°F
10	1.779	1.784	1.789	1.794	1.799	1.804	1.809	1.814	1.819	1.824	1.829	1.834	1.839	50.0
11	1.771	1.776	1.781	1.786	1.791	1.796	1.801	1.806	1.811	1.816	1.820	1.825	1.830	51.8
12	1.762	1.767	1.772	1.777	1.782	1.787	1.792	1.797	1.802	1.807	1.812	1.817	1.822	53.6
13	1.754	1.759	1.764	1.769	1.774	1.779	1.784	1.789	1.794	1.799	1.804	1.809	1.813	55.4
14	1.746	1.751	1.756	1.761	1.765	1.770	1.775	1.780	1.785	1.790	1.795	1.800	1.805	57.2
15	1.737	1.742	1.747	1.752	1.757	1.762	1.767	1.772	1.777	1.782	1.786	1.791	1.796	59.0
16	1.729	1.734	1.739	1.744	1.748	1.753	1.758	1.763	1.768	1.773	1.778	1.783	1.788	60.8
17	1.720	1.725	1.730	1.735	1.740	1.745	1.750	1.755	1.759	1.764	1.769	1.774	1.779	62.6
18	1.712	1.717	1.722	1.726	1.731	1.736	1.741	1.746	1.751	1.756	1.760	1.765	1.770	64.4
19	1.703	1.708	1.713	1.718	1.723	1.727	1.732	1.737	1.742	1.747	1.752	1.756	1.761	66.2
20	1.694	1.699	1.704	1.709	1.714	1.719	1.723	1.728	1.733	1.738	1.743	1.748	1.752	68.0
21	1.686	1.690	1.695	1.700	1.705	1.710	1.715	1.719	1.724	1.729	1.734	1.739	1.743	69.8
22	1.677	1.682	1.686	1.691	1.696	1.701	1.706	1.710	1.715	1.720	1.725	1.730	1.734	71.6
23	1.668	1.673	1.677	1.682	1.687	1.692	1.696	1.701	1.706	1.711	1.716	1.720	1.725	73.4
24	1.659	1.664	1.668	1.673	1.678	1.683	1.687	1.692	1.697	1.702	1.706	1.711	1.716	75.2
25	1.650	1.654	1.659	1.664	1.669	1.673	1.678	1.683	1.688	1.692	1.697	1.702	1.706	77.0
26	1.640	1.645	1.650	1.654	1.659	1.664	1.669	1.673	1.678	1.683	1.687	1.692	1.697	78.8
27	1.631	1.636	1.640	1.645	1.650	1.654	1.659	1.664	1.669	1.673	1.678	1.683	1.687	80.6
28	1.621	1.626	1.631	1.635	1.640	1.645	1.649	1.654	1.659	1.664	1.668	1.673	1.677	82.4
29	1.612	1.616	1.621	1.626	1.630	1.635	1.640	1.644	1.649	1.654	1.658	1.663	1.668	84.2
30	1.602	1.607	1.611	1.616	1.620	1.625	1.630	1.634	1.639	1.644	1.648	1.653	1.658	86.0
31	1.592	1.597	1.601	1.606	1.610	1.615	1.620	1.624	1.629	1.634	1.638	1.643	1.648	87.8
32	1.582	1.587	1.591	1.596	1.600	1.605	1.610	1.614	1.619	1.624	1.628	1.633	1.638	89.6
33	1.572	1.577	1.581	1.586	1.590	1.595	1.599	1.603	1.608	1.613*	1.618	1.623	1.627	91.4
34	1.562	1.566	1.571	1.576	1.580	1.585	1.589	1.593	1.598	1.603	1.607	1.612	1.617	93.2
35	1.551	1.556	1.561	1.565	1.569	1.574	1.579	1.583	1.588	1.592	1.597	1.602	1.606	95.0
Inches	28.34	28.42	28.50	28.58	28.66	28.74	28.82	28.90	28.98	29.06	29.13	29.21	29.29	....

TABLE 2.—*Concluded*

°C. \ mm.	746	748	750	752	754	756	758	760	762	764	736	768	770	°F
10	1.844	1.849	1.854	1.859	1.864	1.869	1.874	1.879	1.884	1.889	1.894	1.899	1.904	50.0
11	1.835	1.840	1.845	1.850	1.855	1.860	1.865	1.870	1.875	1.880	1.885	1.890	1.895	51.8
12	1.827	1.832	1.837	1.842	1.847	1.852	1.857	1.862	1.867	1.872	1.877	1.882	1.887	53.6
13	1.818	1.823	1.828	1.833	1.838	1.843	1.848	1.853	1.858	1.863	1.868	1.873	1.878	55.4
14	1.810	1.815	1.820	1.825	1.830	1.834	1.839	1.844	1.849	1.854	1.859	1.864	1.869	57.2
15	1.801	1.806	1.811	1.816	1.821	1.826	1.831	1.836	1.840	1.845	1.850	1.855	1.860	59.0
16	1.792	1.797	1.802	1.807	1.812	1.817	1.822	1.827	1.832	1.837	1.841	1.846	1.851	60.8
17	1.784	1.789	1.793	1.798	1.803	1.808	1.813	1.818	1.823	1.828	1.833	1.837	1.842	62.6
18	1.775	1.780	1.785	1.790	1.794	1.799	1.804	1.809	1.814	1.819	1.824	1.828	1.833	64.4
19	1.766	1.771	1.776	1.781	1.785	1.790	1.795	1.800	1.805	1.810	1.814	1.819	1.824	66.2
20	1.757	1.762	1.767	1.772	1.776	1.781	1.786	1.791	1.796	1.801	1.805	1.810	1.815	68.0
21	1.748	1.753	1.758	1.763	1.767	1.772	1.777	1.782	1.787	1.791	1.796	1.801	1.806	69.8
22	1.739	1.744	1.749	1.753	1.758	1.763	1.768	1.773	1.777	1.782	1.787	1.792	1.797	71.6
23	1.730	1.735	1.739	1.744	1.749	1.754	1.759	1.763	1.768	1.773	1.778	1.782	1.787	73.4
24	1.721	1.725	1.730	1.735	1.740	1.744	1.749	1.754	1.759	1.763	1.768	1.773	1.778	75.2
25	1.711	1.716	1.721	1.725	1.730	1.735	1.740	1.744	1.749	1.754	1.759	1.763	1.768	77.0
26	1.702	1.706	1.711	1.716	1.721	1.725	1.730	1.735	1.739	1.744	1.749	1.754	1.758	78.8
27	1.692	1.697	1.701	1.706	1.711	1.716	1.720	1.725	1.730	1.734	1.739	1.744	1.748	80.6
28	1.682	1.687	1.692	1.696	1.701	1.706	1.710	1.715	1.720	1.724	1.729	1.734	1.739	82.4
29	1.672	1.677	1.682	1.686	1.691	1.696	1.700	1.705	1.710	1.714	1.719	1.724	1.728	84.2
30	1.662	1.667	1.672	1.676	1.681	1.686	1.690	1.695	1.700	1.704	1.709	1.714	1.718	86.0
31	1.652	1.657	1.662	1.666	1.670	1.675	1.680	1.685	1.689	1.694	1.699	1.703	1.708	87.8
32	1.642	1.646	1.651	1.656	1.660	1.664	1.669	1.674	1.679	1.683	1.688	1.693	1.697	89.6
33	1.631	1.636	1.641	1.645	1.649	1.654	1.659	1.664	1.668	1.673	1.677	1.682	1.687	91.4
34	1.620	1.625	1.630	1.635	1.639	1.643	1.648	1.653	1.658	1.662	1.666	1.671	1.676	93.2
35	1.610	1.615	1.620	1.624	1.629	1.633	1.638	1.643	1.647	1.651	1.656	1.660	1.665	95.0
Inches	29.37	29.45	29.53	29.61	29.68	29.76	29.84	29.92	30.00	30.08	30.16	30.24	30.31	....

TABLE 3.—WEIGHT OF DRY AIR IN MILLIGRAMS PER CUBIC CENTIMETER OF SATURATED ATMOSPHERE

°C. \ mm.	720	722	724	726	728	730	732	734	736	738	740	742	744	°F
10	1.168	1.171	1.174	1.177	1.180	1.184	1.187	1.190	1.193	1.197	1.200	1.203	1.206	50.0
11	1.162	1.166	1.169	1.172	1.175	1.179	1.182	1.185	1.188	1.191	1.195	1.198	1.201	51.8
12	1.157	1.160	1.164	1.167	1.170	1.173	1.177	1.180	1.183	1.186	1.189	1.193	1.196	53.6
13	1.152	1.155	1.159	1.162	1.165	1.168	1.171	1.175	1.178	1.181	1.184	1.187	1.190	55.4
14	1.147	1.150	1.153	1.157	1.160	1.163	1.166	1.169	1.172	1.176	1.179	1.182	1.185	57.2
15	1.142	1.145	1.148	1.151	1.154	1.158	1.161	1.164	1.167	1.170	1.173	1.177	1.180	59.0
16	1.137	1.140	1.143	1.146	1.149	1.152	1.156	1.159	1.162	1.165	1.168	1.171	1.174	60.8
17	1.131	1.134	1.138	1.141	1.144	1.147	1.150	1.153	1.156	1.160	1.163	1.166	1.169	62.6
18	1.126	1.129	1.132	1.135	1.138	1.141	1.145	1.148	1.151	1.154	1.157	1.160	1.163	64.4
19	1.121	1.124	1.127	1.130	1.133	1.136	1.139	1.142	1.146	1.149	1.152	1.155	1.158	66.2
20	1.115	1.118	1.121	1.124	1.128	1.131	1.134	1.137	1.140	1.143	1.146	1.149	1.152	68.0
21	1.110	1.113	1.116	1.119	1.122	1.125	1.128	1.131	1.134	1.138	1.141	1.144	1.147	69.8
22	1.104	1.107	1.110	1.113	1.117	1.120	1.123	1.126	1.129	1.132	1.135	1.138	1.141	71.6
23	1.099	1.102	1.105	1.108	1.111	1.114	1.117	1.120	1.123	1.126	1.129	1.132	1.135	73.4
24	1.093	1.096	1.099	1.102	1.105	1.108	1.111	1.114	1.117	1.120	1.123	1.126	1.130	75.2
25	1.087	1.090	1.093	1.096	1.099	1.102	1.106	1.109	1.112	1.115	1.118	1.121	1.124	77.0
26	1.082	1.085	1.088	1.091	1.094	1.097	1.100	1.103	1.106	1.109	1.112	1.115	1.118	78.8
27	1.076	1.079	1.082	1.085	1.088	1.091	1.094	1.097	1.100	1.103	1.106	1.109	1.112	80.6
28	1.070	1.073	1.076	1.079	1.082	1.085	1.088	1.091	1.094	1.097	1.100	1.103	1.106	82.4
29	1.064	1.067	1.070	1.073	1.077	1.079	1.082	1.085	1.088	1.090	1.093	1.096	1.099	84.2
30	1.058	1.061	1.064	1.067	1.070	1.073	1.075	1.078	1.081	1.084	1.087	1.090	1.093	86.0
31	1.052	1.055	1.058	1.060	1.063	1.066	1.069	1.072	1.075	1.078	1.081	1.084	1.087	87.8
32	1.045	1.048	1.051	1.054	1.057	1.060	1.063	1.066	1.069	1.071	1.074	1.077	1.080	89.6
33	1.039	1.042	1.045	1.048	1.051	1.053	1.056	1.059	1.062	1.065	1.068	1.071	1.074	91.4
34	1.032	1.035	1.038	1.041	1.044	1.047	1.050	1.053	1.055	1.058	1.061	1.064	1.067	93.2
35	1.026	1.029	1.032	1.034	1.037	1.040	1.043	1.046	1.049	1.052	1.054	1.057	1.060	95.0
Inches	28.34	28.42	28.50	28.58	28.66	28.74	28.82	28.90	28.98	29.06	29.13	29.21	29.29	....

TABLE 3.—*Concluded*

°C. \ mm.	746	748	750	752	754	756	758	760	762	764	766	768	770	°F
10	1.210	1.213	1.216	1.219	1.223	1.226	1.229	1.232	1.236	1.239	1.242	1.245	1.249	50.0
11	1.204	1.208	1.211	1.214	1.217	1.220	1.224	1.227	1.230	1.233	1.237	1.240	1.243	51.8
12	1.199	1.202	1.206	1.209	1.212	1.215	1.218	1.222	1.225	1.228	1.231	1.234	1.238	53.6
13	1.194	1.197	1.200	1.203	1.207	1.210	1.213	1.216	1.219	1.223	1.226	1.229	1.232	55.4
14	1.188	1.192	1.195	1.198	1.201	1.204	1.208	1.211	1.214	1.217	1.220	1.223	1.227	57.2
15	1.183	1.186	1.189	1.193	1.196	1.199	1.202	1.205	1.208	1.211	1.215	1.218	1.221	59.0
16	1.178	1.181	1.184	1.187	1.190	1.193	1.197	1.200	1.203	1.206	1.209	1.212	1.215	60.8
17	1.172	1.175	1.178	1.181	1.185	1.188	1.191	1.194	1.197	1.200	1.203	1.207	1.210	62.6
18	1.167	1.170	1.173	1.176	1.179	1.182	1.185	1.189	1.192	1.195	1.198	1.201	1.204	64.4
19	1.161	1.164	1.167	1.170	1.173	1.177	1.180	1.183	1.186	1.189	1.192	1.195	1.198	66.2
20	1.156	1.159	1.162	1.165	1.168	1.171	1.174	1.177	1.180	1.183	1.186	1.190	1.193	68.0
21	1.150	1.153	1.156	1.159	1.162	1.165	1.168	1.171	1.175	1.178	1.181	1.184	1.187	69.8
22	1.144	1.147	1.150	1.153	1.156	1.159	1.162	1.166	1.169	1.172	1.175	1.178	1.181	71.6
23	1.138	1.141	1.144	1.148	1.151	1.154	1.157	1.160	1.163	1.166	1.169	1.172	1.175	73.4
24	1.133	1.136	1.139	1.142	1.145	1.148	1.151	1.154	1.157	1.160	1.163	1.166	1.169	75.2
25	1.127	1.130	1.133	1.136	1.139	1.142	1.145	1.148	1.151	1.154	1.157	1.160	1.163	77.0
26	1.121	1.124	1.127	1.130	1.133	1.136	1.139	1.142	1.145	1.148	1.151	1.154	1.157	78.8
27	1.115	1.118	1.121	1.124	1.127	1.130	1.133	1.136	1.139	1.142	1.145	1.148	1.151	80.6
28	1.108	1.111	1.114	1.117	1.120	1.123	1.126	1.129	1.132	1.135	1.138	1.141	1.144	82.4
29	1.102	1.105	1.108	1.111	1.114	1.117	1.120	1.123	1.126	1.129	1.132	1.135	1.138	84.2
30	1.096	1.099	1.102	1.105	1.108	1.111	1.114	1.117	1.120	1.122	1.125	1.128	1.131	86.0
31	1.090	1.093	1.095	1.098	1.101	1.104	1.107	1.110	1.113	1.116	1.119	1.122	1.125	87.8
32	1.083	1.086	1.089	1.092	1.095	1.098	1.100	1.103	1.106	1.109	1.112	1.115	1.118	89.6
33	1.076	1.079	1.082	1.085	1.088	1.091	1.094	1.097	1.100	1.102	1.105	1.108	1.111	91.4
34	1.070	1.073	1.076	1.078	1.081	1.084	1.087	1.090	1.093	1.096	1.098	1.101	1.104	93.2
35	1.063	1.066	1.069	1.072	1.074	1.077	1.080	1.083	1.086	1.089	1.091	1.094	1.097	95.0
Inches	29.37	29.45	29.53	29.61	29.68	29.76	29.84	29.92	30.00	30.08	30.16	30.24	30.31	...

LIMESTONE SAMPLES

In collecting limestone for analysis, care should be taken to secure a sample which will fairly represent the stone, because even an accurate analysis does not tell the whole truth if an imperfect sample is analyzed. To sample a stratum of stone it is well to chip off small pieces every few inches from top to bottom. If about the same amount is taken from each point, the composite will represent the stratum. If two or more strata exist and it is desired to know the relative purity of each, then a separate composite sample should be taken from each stratum.

It should be kept in mind that samples taken from natural exposures, or rock outcrops, may not fairly represent the unweathered stone. As a rule, calcium carbonate is more readily soluble in rain water than are the impurities which may be associated with it in the natural stone, and consequently the weathered outcrop may contain a lower percentage of carbonate.

In collecting a sample from a carload of pulverized limestone, twenty or more small portions should be taken from different places and different depths, and these, aggregating one or two pounds, should be well mixed for the composite sample. Practically all limestone deposits contain strata which differ more or less in relative purity, and it is easily possible that the last 1,000 pounds of pulverized limestone loaded into a car may have come from a stratum whose composition is appreciably better or poorer than the average. Of course the stone migl.. vary even by carload lots, and no source of limestone should be condemned, or even discriminated against, because one carload has been found "off grade."

The purest limestone is not always the most economical to use. Thus it is better to apply stone of 80 percent purity costing \$1.50 a ton spread on the land, than stone of 98 percent purity costing \$2. equal fineness being assumed.

For use in soil improvement, the limestone need not be very finely ground, but it should include all of the fine dust produced in the process of crushing or grinding. At least four important factors are involved in the question of fineness: cost of production, cost of application, durability, and availability. Stone ground to pass thru a 10-mesh sieve (100 holes per square inch) costing \$2 a ton spread on the land is more expensive than stone with only 75 percent of 10-mesh at \$1.50 a ton, because the stone which is coarser than 10-mesh costs nothing, relatively, and it has some value. Its value may be even greater than that of an equal weight of the finer stone, when measured solely by its effects after the second or third year.

It costs less to spread three tons of limestone at one application than to spread them in six annual applications of 1000 pounds each. If three tons are applied every six years, the finer material is needed

for quick availability, and the coarser may be equally important to provide for durability of benefit. Investigations now in progress will ultimately furnish more information in regard to this question of fineness. From the information thus far secured, it is conceivable that limestone ground so that 90 percent will pass thru a 4-mesh sieve (16 holes per square inch) and 50 percent thru a 10-mesh may prove as economical as any for use in permanent rational systems of soil improvement.

COST OF LIMESTONE TESTER

The cost of an outfit for testing limestone as described herein is less than $10. This includes the tester shown on the second page, a balance, a set of weights, a forceps for handling the weights, a mortar and pestle for pulverizing the stone, a 25 cubic centimeter graduated cylinder to be used for measuring the air space in the tester and useful also in transferring acid to the apparatus, and a spatula for placing the pulverized stone on the balance pan. (After weighing, the 5 grams of stone may be poured onto a small square of clean paper, previously creased, and from this poured into the tester, which should stand on a larger piece of clean paper, so that if any stone is spilled it can be recovered.)

The Illinois Experiment Station will be glad to assist anyone desiring to secure this outfit. (Strong hydrochloric acid can be secured from drug stores, and thermometers are already present in most homes and offices.)